Calculating optimum location for Courier distribution depot for any city

1. Introduction:

Company X is one of the largest international courier, package delivery and express mail service. The company delivers billions of parcels per year throughout the globe.

As a global company, **Company X** operates in more than 200 countries and regions, or that they often enter new markets as the first logistics company. It's intention is to be a logistics company to which people will return - they will be their first choice not only by delivering their shipments, but also as an employer or investor.

Companies mission consists of four main elements:

- They make our customers, employees and investors even more successful;
- They always show respect while achieving high scores;
- They facilitate and simplify the lives of our customers;
- And contribute to making our world better.

They operate on this notation that, it is also in the interest of their stakeholders: customers, employees, investors, to achieve all these goals. By interacting with **Company X** Parcel, customers benefit from great services.

Recently, as an initiative to ensure better customer service and expand it's business horizon in a sustainable and scientific process, **Company X** is looking for a tool to revamp geographical distribution of their delivery depots.

The goal of the proposed solution would be to, analyze the important landmark distributions of different cities and propose suitable geographical locations for delivery depots to facilitate efficient and prompt customer service.

A list of cities where the company is currently operating or may open operation in near future is provided.

Although subsequent analysis, discussion and methodology is targeted to present a suitable solution for **Company X**, but the same method could be applied for calculating optimal location of delivery depots for any entity that is involved in retail distribution business and hence can be regarded as prospective interested parties.

2. Data:

Data source: https://simplemaps.com/data/world-cities.

Sample rows/columns of City location data provided by **Company X** is as below:

City	Lat	Lng	Country	Capital	Population
Tokyo	35.6897	139.6922	Japan	primary	37977000
Jakarta	-6.2146	106.8451	Indonesia	primary	34540000
Delhi	28.66	77.23	India	admin	29617000
Mumbai	18.9667	72.8333	India	admin	23355000
Manila	14.5958	120.9772	Philippines	primary	23088000
Shanghai	31.1667	121.4667	China	admin	22120000
São Paulo	-23.5504	-46.6339	Brazil	admin	22046000
Seoul	37.5833	127	Korea, South	primary	21794000
Mexico City	19.4333	-99.1333	Mexico	primary	20996000
Cairo	30.0561	31.2394	Egypt	primary	19372000
New York	40.6943	-73.9249	United States		18713220
Kolkāta	22.5411	88.3378	India	admin	17560000
Moscow	55.7558	37.6178	Russia	primary	17125000
……	……	……	……..	……	……..

Relevant column details:

Sl#	Column Title	Details
1	City	City name
2	Country	Country name
3	Lat	City latitude
4	Lng	City longitude
5	Capital	Whether primary/admin capital
6	Population	Current city population

3. Methodology:

To address the subject requirement, ***Foursquare location data service(FLDS)*** is used. More specifically:

- **venues/categories** : Returns a hierarchical list of categories applied to venues.
- **venues/search**: Returns a list of venues near the current location, optionally matching a search term.

apis are used. Using *venues/categories* api I got all the venue category details used by FLDS. Each venue category also contains sub categories.

Using *venues/search* api along with target *city lat/lng* data and top level venue *categoryId*s I fetched all target venues in the vicinity of any target city.

Important columns of *venues data-frame* are as below:

Sl#	Column Title	Details
1	Name	Venue name
2	Distance	Distance in m from city center
3	Lat	Venue latitude
4	Lng	Venue longitude
5	Postal-code	Postal code of venue
6	Address	Venue address

After that, applying ***k-means clustering*** algorithm on venue location data and varying cluster size I calculated the suitable delivery depot latitude & longitude from the kmeans cluster centers.

Finally, to get the actual physical address of the proposed delivery depots given by ***k-means clustering*** reverse Geo-coding service of *https://revgeocode.search.hereapi.com api is used.*

To plot the venues and proposed depot location I used ***folium*** library.

4. Result:

As per the above mentioned procedure analysis was run for two cities namely Toronto,Canada and Mumbai, India. Results are as below.

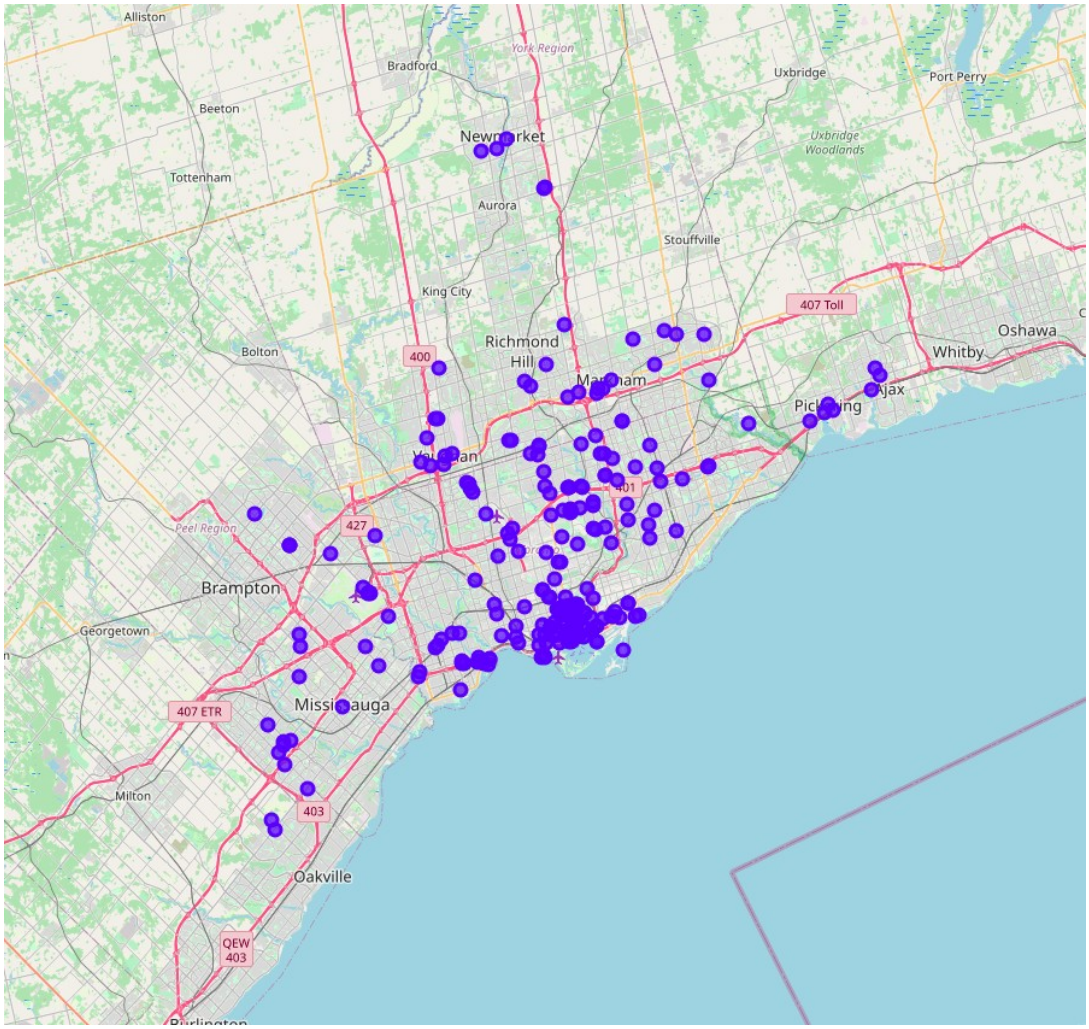
Toronto, Canada:

Total 248 Venues were found within 20km radius of Toronto city using Foursquare api. Part of venues data-frame is as below:

name	lat	lng	address	cat_name
Toronto Botanical Garden	43.7341	-79.3583	777 Lawrence Avenue East (Leslie St.),Toronto ON M3C 1P2,Canada	Arts & Entertainment
Mrs. Claus' Sweatshop	43.7538	-79.3195	Cassandra Blvd. (at Mar's Toad Lillypad),Toronto ON,Canada	Arts & Entertainment
Maja Prentice Theatre	43.6213	-79.6028	Burnhamthorpe And Dixie,Mississauga ON,Canada	Arts & Entertainment
International Living and Learning Centre	43.6587	-79.3753	240 Jarvis St. (btwn Dundas & Gerrard),Toronto ON M5B 2L1,Canada	College & University
Loblaws	43.6609	-79.3283	17 Leslie St (at Lakeshore Blvd.),Toronto ON M4M 3H9,Canada	Food
Carlo's No Frills	43.7947	-79.4216	6220 Yonge St (at Steeles Ave. W),North York ON M2M 3X4,Canada	Food
Starbucks	43.777	-79.3440	1800 Sheppard Ave E,Toronto ON M2J 5A7,Canada	Food
Rebel House	43.6776	-79.3899	1068 Yonge St. (btwn Roxborough St. & Gibson Ave.),Toronto ON M4W 2L4,Canada	Nightlife Spot
Bellwoods Brewery	43.6470	-79.4199	124 Ossington Ave (at Argyle St),Toronto ON M6J 2Z5,Canada	Nightlife Spot
Great Lakes Brewery	43.6227	-79.5046	33 Queen Elizabeth Blvd (at Royal York Rd),Toronto ON M8Z 1L8,Canada	Nightlife Spot
Irving Paisley Park	43.7481	-79.3824	Canada	Outdoors & Recreation
Tubby Wubby	43.7371	-79.2948	Canada	Outdoors & Recreation
York mills arena	43.7493	-79.3844	York mills and bayview,Toronto ON M2L,Canada	Outdoors & Recreation
Earnscliffe Park	43.7208	-79.7041	Canada	Outdoors & Recreation
East Collision Reporting Centre	43.7496	-79.2887	39 Howden Rd. (at Lawrence Ave. E),Toronto ON,Canada	Professional & Other

				Places
Brampton Civic Hospital	43.7461	-79.7438	2100 Bovaird Dr. E,Brampton ON L6R,Canada	Professional & Other Places
Mystic Pointe	43.6244	-79.4903	250 Manitoba St,Toronto ON,Canada	Professional & Other Places
Ice Condominiums	43.6416	-79.3816	12 & 14 York St (at Lake Shore Blvd W),M5J 0A9,Canada	Residence
The Bay Club	43.6643	-79.3868	925 Bay St. (at Wellesley St. W.),Toronto ON,Canada	Residence
Bayview Village	43.7685	-79.3854	2901 Bayview Ave. (at Sheppard Ave. E),Toronto ON M2K 1E6,Canada	Residence
Walmart Supercentre	44.0149	-79.4128	135 First Commerce Dr (at Wellington St E),Aurora ON L4G 0G2,Canada	Shop & Service
Hillcrest	43.8548	-79.4362	9350 Yonge Street,Richmond Hill ON L4C 5G2,Canada	Shop & Service
SmartCentres Aurora	44.0138	-79.4153	Canada	Shop & Service
St Clair West Subway Station	43.6839	-79.4153	370 St Clair Ave. W. (at Bathurst St.),Toronto ON M5P 1N4,Canada	Travel & Transport
Concourse D	43.6812	-79.6148	Terminal 1 (Toronto Pearson International Airport),Mississauga ON,Canada	Travel & Transport
St. George Subway Station	43.6682	-79.3997	323 Bloor St W (at St George St),Toronto ON M5S 1W7,Canada	Travel & Transport

Folium plot of all Toronto venues:

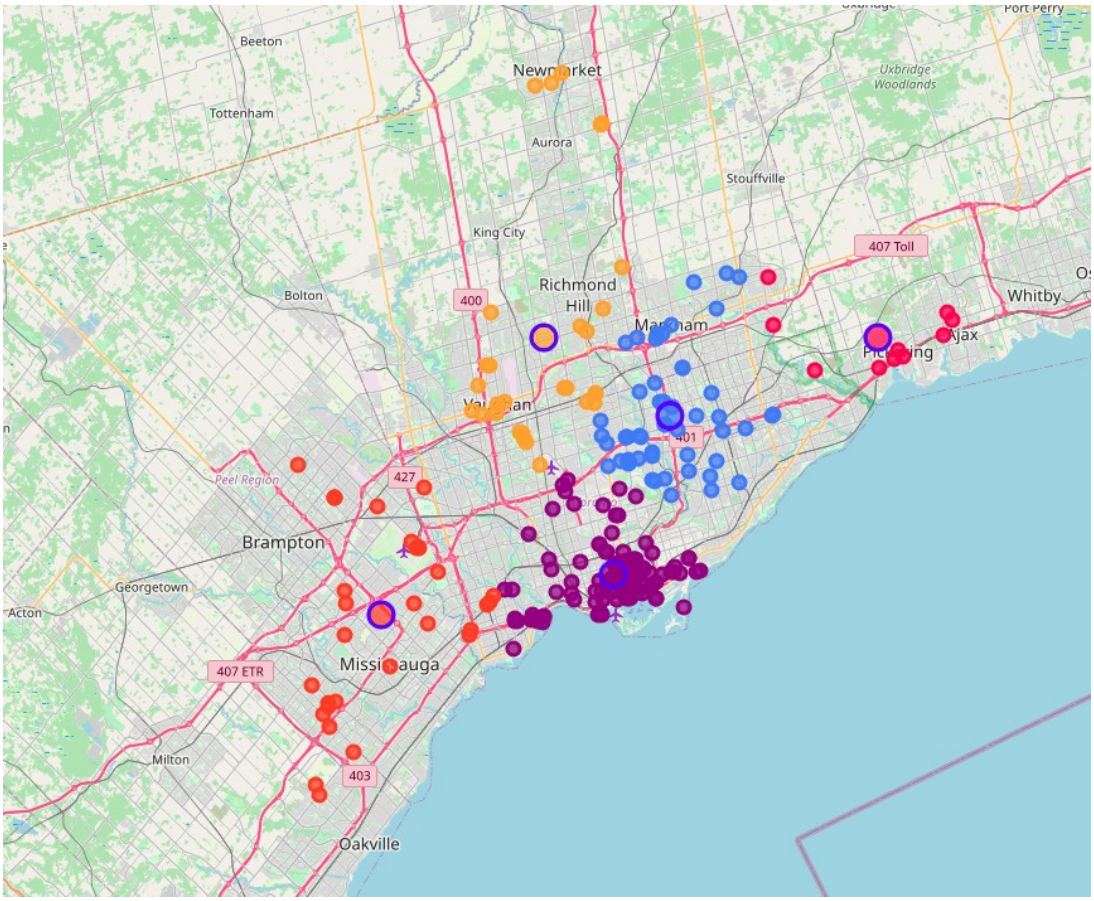


html version of above plot:
https://github.com/dasBikash84/Coursera_Capstone/blob/master/Toronto_only_venues.html

Running KMeans clustering (for 5 clusters) algorithm on venue location data optimum depot location (lat,lng) was calculated. And using above mentioned reverse Geo-coding service the final result is as below:

Depot Id#	Lat	Lng	Address
1	43.8408	-79.1422	RR-27, Pickering, ON L1V, Canada
2	43.6602	-79.4010	570 Spadina Ave, Toronto, ON M5S 2H2, Canada
3	43.6278	-79.6531	LG Electronics Canada (Goldstar), 550 Matheson Blvd E, Mississauga, ON L4Z, Canada
4	43.7837	-79.3513	3000 Don Mills Rd E, Toronto, ON M2J 3B6, Canada
5	43.8545	-79.4849	150 Upper Post Rd, Vaughan, ON L6A 4J9, Canada

Folium plot of all Toronto venues with proposed depot location:



html version of above plot:
https://github.com/dasBikash84/Coursera_Capstone/blob/master/Toronto_venues_with_depots.html

On above plot, 5 blue outlined circles with larger radius marks the proposed depot locations. And venues of same fill color as depot fill color, are under that very depot.

Mumbai, India:

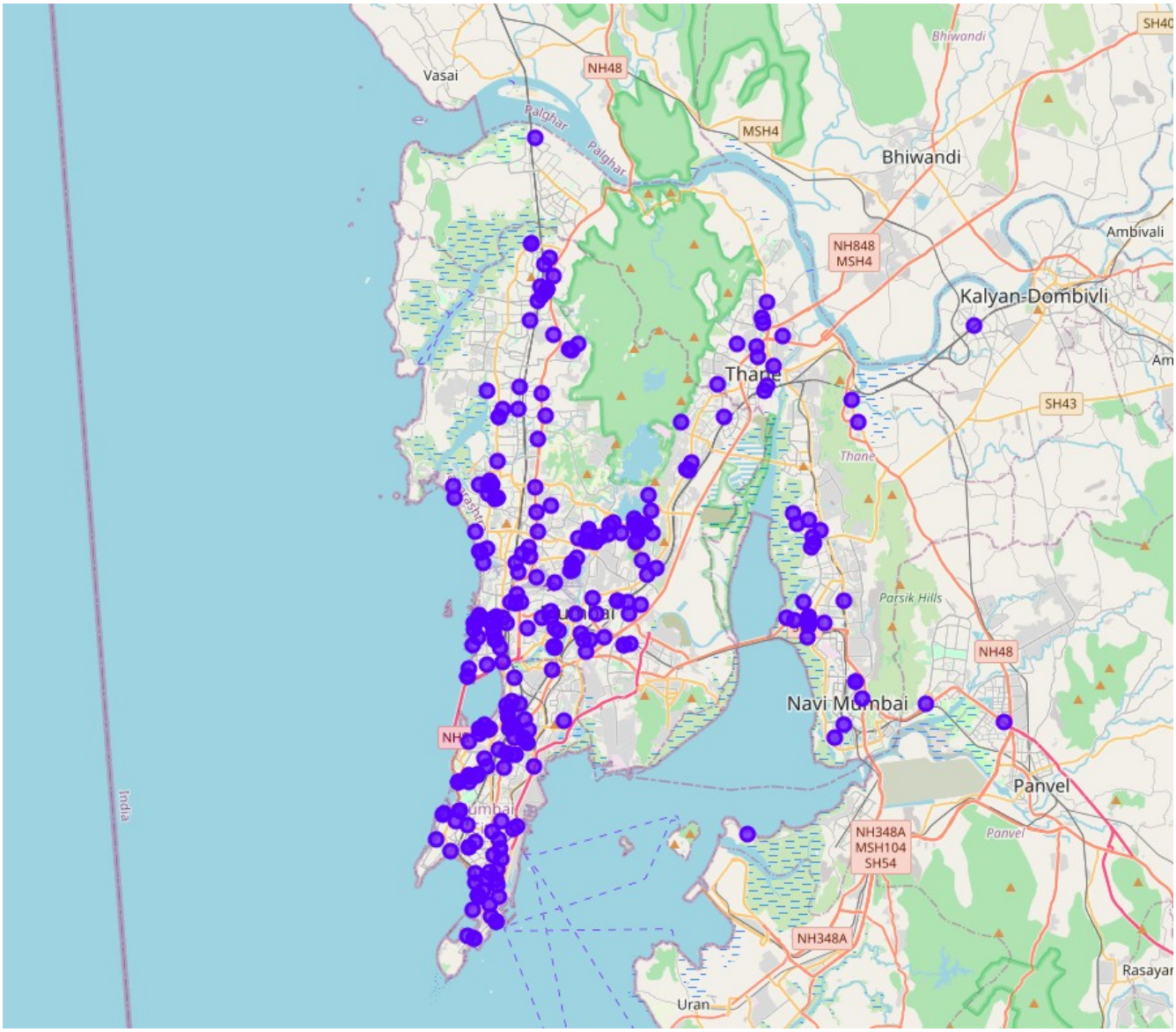
Total 268 Venues were found within 20km radius of Mumbai city using Foursquare api. Part of venues data-frame is as below:

name	lat	lng	address	cat_name
Dongri	18.9582	72.8363	Charnull (Dongri),Mumbai 400009,Mahārāshtra,India	Arts & Entertainment
Avignyata Inc.	19.0944	72.9142	Vadhani Industrial Estate (L.B.S. Marg, Ghatkopar),Mumbai 400089,Mahārāshtra,India	Arts & Entertainment
Gateway of India	18.9218	72.8348	Apollo Bandar, Off P J Ramchandani Marg (near the Taj Mahal Palace & Tower),Mumbai 400001,Mahārāshtra,India	Arts & Entertainment
Grant Medical College	18.9627	72.8360	JJ hospital,Mumbai,Mahārāshtra,India	College & University
Thakur College of Engineering and Technology	19.2061	72.8741	Shyamnarayan Thakur Marg,Mumbai 400 101,Mahārāshtra,India	College & University
IIT Bombay	19.1263	72.9164	Adi Shankaracharya Marg (Powai),Mumbai 400076,Mahārāshtra,India	College & University
Richardson and Cruddas	18.9664	72.8327	Sir J. J. Road (Byculla),Mumbai,Mahārāshtra,India	Event
kristuraj church	19.1128	72.8779	India	Event
Sarvajanik Ganeshotsav Mandal, Sector-17.	19.0714	72.9991	Ratmata Jijamata Chowk, Sector-17,Vashi 400703,Mahārāshtra,India	Event
Pamya Dosa	18.9716	72.8376	Mumbai,Mahārāshtra,India	Food
Starbucks	19.1163	72.9097	G2, Prudential Building, Hiranandani Business Park (Powai),Mumbai,Mahārāshtra,India	Food
Blue Tokai Coffee Roasters	19.1327	72.812	Palm Beach Apartments, J. P. Nagar, Aram Nagar (Versova),Mumbai 400061,Mahārāshtra,India	Food
Dockyard	18.9679	72.8433	India	Nightlife Spot
Jugheads	19.2304	72.9771	R-mall (Ghodbunder Road),Thāne,Mahārāshtra,India	Nightlife Spot
Mia Cucina	19.1201	72.9072	G3 Transocean, Lake Boulevard Street, Hiranandani Business Park, (Powai),Mumbai 400076,Mahārāshtra,India	Nightlife Spot

Carter Road Promenade	19.0672	72.8229	Naushad Ali Marg (Bandra (W)),Mumbai 400052,Mahārāshtra,India	Outdoors & Recreation
Marine Drive	18.9412	72.8232	Marine Drive,Mumbai 400 020,Mahārāshtra,India	Outdoors & Recreation
Gateway of India	18.9218	72.8348	Apollo Bandar, Off P J Ramchandani Marg (near the Taj Mahal Palace & Tower),Mumbai 400001,Mahārāshtra,India	Outdoors & Recreation
Sir H. N. Reliance Foundation Hospital and Research Centre	18.9588	72.8202	Raja Rammohan Roy Road (Prarthana Samaj, Girgaon),Mumbai 400004,Mahārāshtra,India	Professional & Other Places
Gateway of India	18.9218	72.8348	Apollo Bandar, Off P J Ramchandani Marg (near the Taj Mahal Palace & Tower),Mumbai 400001,Mahārāshtra,India	Professional & Other Places
Taj Lands End	19.0436	72.8192	Band Stand , Byramji Jeejeebhoy Rd. (Bandra (West)),Mumbai 400 050,Mahārāshtra,India	Professional & Other Places
Lodha Paradise	19.2130	72.9853	Majiwade (Eastern Express Highway),Thāne 400601,Mahārāshtra,India	Residence
Anand Park	19.2594	72.8529	Anand Park (Kandarpada Road),Mumbai 400068,Mahārāshtra,India	Residence
Shiv Shrusti	19.0559	72.8817	Kurla East,Mumbai,Mahārāshtra,India	Residence
Masjid Bunder Market	18.9532	72.8370	India	Shop & Service
C'raj's	19.1510	72.8355	3 , Vaibhav Palace , opp Mega Mall (Oshiwara),Mumbai 400102,Mahārāshtra,India	Shop & Service
Car Care Paradise	18.9131	72.8228	Garage # 4 Heliopolis Bldg, Near Colaba Post-Office (Shahid Bhagat Singh Road, Colaba),Mumbai 400005,Mahārāshtra,India	Shop & Service
Mumbai Central Railway Station	18.9696	72.8195	Dr Anandrao Nair Marg (Mumbai Central),Mumbai 400008,Mahārāshtra,India	Travel & Transport
Chhatrapati Shivaji International Airport	19.0905	72.8651	Western Express Hwy,Mumbai 400099,Mahārāshtra,India	Travel & Transport
Terminal 2	19.0990	72.8748	Chhatrapati Shivaji International	Travel &

			Airport (Sahar),Mumbai 400099,Mahārāshtra,India	Transport

Folium plot of all Mumbai venues:

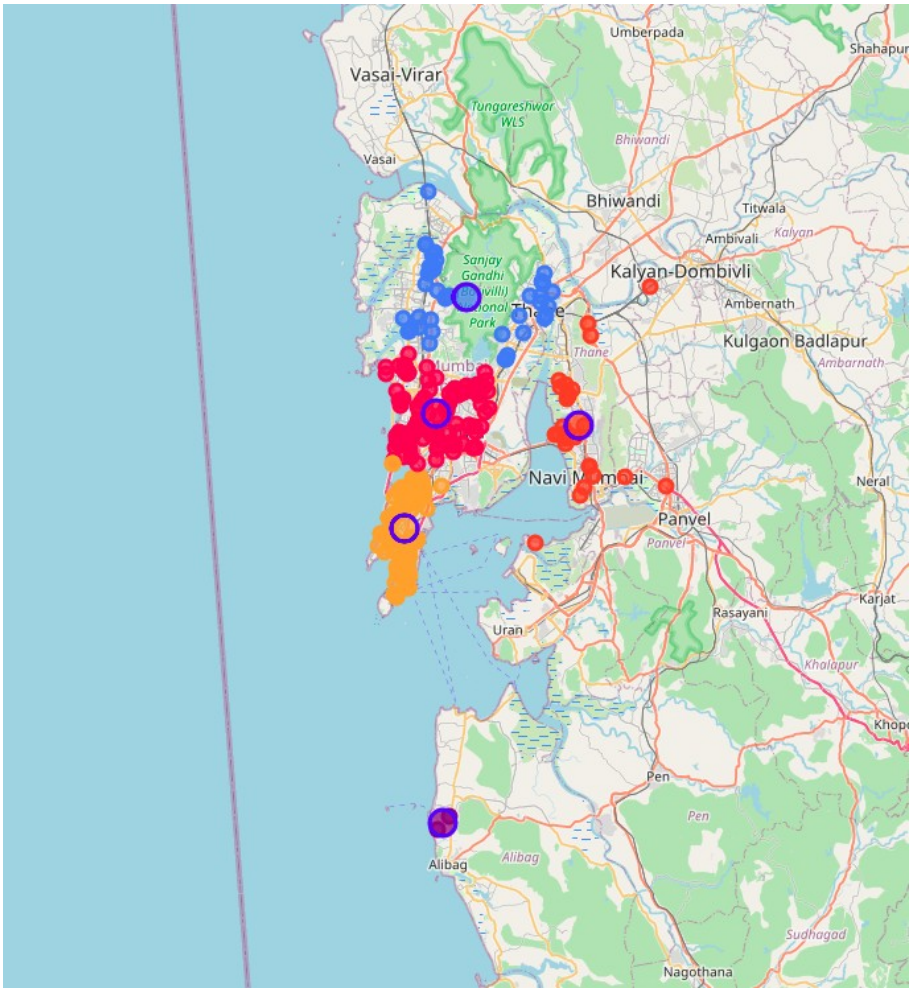


html version of above plot:
https://github.com/dasBikash84/Coursera_Capstone/blob/master/Mumbai_only_venues.html

Running KMeans clustering (for 5 clusters) algorithm on venue location data of Mumbai, optimum depot location (lat,lng) was calculated. And using above mentioned reverse Geo-coding service the final result is as below:

lat	lng	address
18.98	72.83	Bit Chawl, Byculla, Mumbai 400011, India
19.21	72.9	Kanheri Caves Road, Sanjay Gandhi National Park, Wagle Industry Estate, Mumbai 400101, India
19.09	72.86	A A I Tower, Sahar Village-Sutar Pakhadi, Andheri East, Mumbai 400099, India
19.08	73.01	Hansraj Khimraj & Company, Sector 19a, Vashi, Navi Mumbai 400703, India
18.69	72.87	Thal Road, Alibag Sub-District 402207, India

Folium plot of all Mumbai venues with proposed depot location:



html version of above plot:
https://github.com/dasBikash84/Coursera_Capstone/blob/master/Mumbai_venues_with_depots.html

On the plot, 5 blue outlined circles with larger radius marks the proposed depot locations. And venues of same fill color as depot fill color are under that very depot.

5. Discussion:

Following above mentioned method of subject notebook suitable delivery depot locations can be calculated for any city of the mentioned city data-frame.

Moreover, using mentioned tools and procedures, optimum geographical distribution of delivery depots for any other business venture can be easily calculated.

6. Conclusions

In this project, I formulated a methodology to figure out optimum geographical distribution of delivery depots for any target city. In doing so, *Foursquare api* was used to get relevant venue data for target city. After that, Kmeans clustering algorithm was used to cluster venues according to their latitude and longitude and pin point optimum depot location. On top of that, reverse Geo-coding api was used to get physical addresses of suggested delivery depots. It was a great learning experience for me and I hope any other business entity involved in retail goods distribution will find this method useful and interesting.